# OPERATING AND MAINTENANCE MANUAL

**KROHN-HITE CORPORATION**

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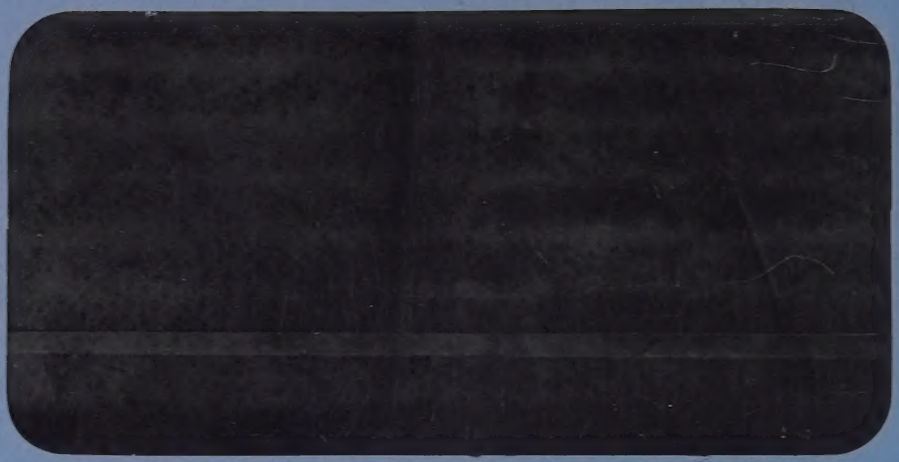

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SOLID STATE

# TEST OSCILLATOR

MODEL 4200(R) SERIAL NO.____

# OPERATING AND MAINTENANCE MANUAL

**KROHN-HITE CORPORATION**
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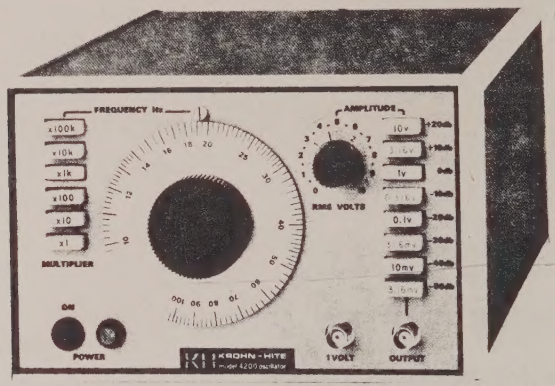
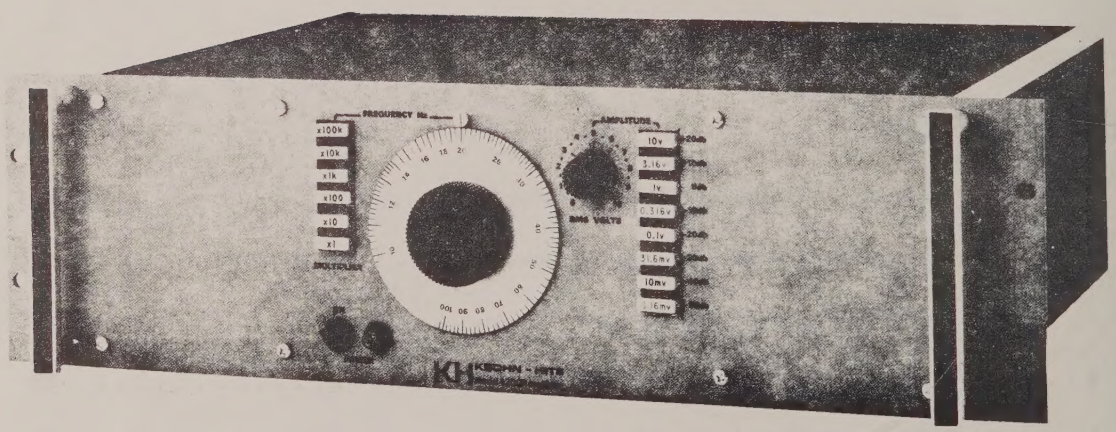



Model 4200




Model 4200R

Figure 1. Models 4200 and 4200R Oscillator

# SECTION 1

# GENERAL DESCRIPTION

## 1.1 INTRODUCTION

This manual provides operation and maintenance instructions with detailed specifications, schematic diagram, and parts list for the Model 4200 and Model 4200R Test Oscillator, illustrated in Figure 1. The R after the model number indicates that the unit is provided with a front panel and chassis suitable for standard rack mounting.

Reference to Operating Instructions, Section 2, is recommended before this Oscillator is put into operation. In the event the Oscillator is not functioning or fails to meet performance specifications, it should be determined if the normal adjustments mentioned in the Calibration and Adjustment procedure, Section 5, will correct the trouble. If this does not correct the trouble refer to the Maintenance procedure, Section 4.

## 1.2 DESCRIPTION

The Model 4200 is an all silicon, solid state, general purpose Test Oscillator that provides a main sine wave and an auxiliary sine wave from 10Hz to 10MHz. It operates from an ac source of 115 or 230V, 50-400 Hz.

The main sine wave output is variable from 0 to 10 volts rms open-circuit or 5 volts rms across 50 ohms. Maximum power output is 1/2 watt with less than 0.1% harmonic distortion. The auxiliary output is a sine wave fixed at 1 volt rms open circuit.

## 1.3 TECHNICAL SUMMARY

### Frequency Range

10Hz to 10MHz continuously variable

| MULTIPLIER | FREQUENCY (Hz) |
|---|---|
| 1 | 10-100 |
| 10 | 100-1,000 |
| 100 | 1,000-10,000 |
| 1000 | 10,000-100,000 |
| 10,000 | 100,000-1,000,000 |
| 100,000 | 1,000,000-10,000,000 |

### Frequency Control

A single turn dial calibrated from 9.8 to 102 to read directly in Hertz and a six position pushbutton multiplier. A concentric control provides a vernier drive for fine adjustment of frequency.

### Frequency Calibration Accuracy

±2% from 100Hz to 1MHz, rising to ±3% at 10Hz and 10MHz.

### Frequency Stability

Vs. Time: Short term (one minute or less) ±0.002%. In any period of one hour or less, ±0.01%.

Vs. Temperature: Within ±0.05% per degree C from 10Hz to 10MHz.

### External Synchronization

A 1.5 volt peak to peak external signal will lock Oscillator over a range of approximately ±0.5% with no change in distortion and amplitude for a sine wave synchronizing signal. See Section 2.3.

### Sine Wave Output

Power: 1/2 watt (10Hz to 10MHz).

Voltage: 10 volts rms open circuit.

Current: 100 milliamperes rms

Impedance: Constant 50 ohms ±1%.

Output Circuitry: Direct coupled.

DC Component: Nominal zero volts. At maximum output drift is less than 2 millivolts per degree C, less than 1 millivolt for a 10% line voltage change. Drift reduced in proportion to pushbutton attenuator setting.

Distortion: Less than 0.1% from 100Hz to 100kHz rising to .5% at 10Hz and 4% at 10MHz, into a matched 50 ohm load.

**Amplitude Stability**

Vs. Time: In any period of one hour or less within ±0.02%. In any period of 20 hours or less, within ±0.1%.

Vs. Line: For a 10% change in line voltage less than ±0.01% from 10Hz to 10MHz.

Vs. Temperature: Within ±0.1% per degree C.

Frequency Response: Within ±0.025db from 10Hz to 500kHz, rising to ±0.5db at 10MHz, into a matched 50 ohm load.

Amplitude Control: Eight position pushbutton attenuator calibrated in open circuit voltage and 10db steps from +20 to -50db plus an infinite resolution potentiometer calibrated in RMS volts from 0 to 3.16 and 0 to 10. Attenuator accuracy: ±0.2db of pushbutton setting from 10Hz to 10MHz.

**Auxiliary Output**

Voltage: Fixed at 1 volt RMS open circuit.

Impedance: 600 ohms.

DC Component: Zero.

**Power Requirements**

105-125 or 210-250 volts single phase, 50-400Hz, 30 watts.

**Ambient Temperature Range**

0°C to 50°C.

**Terminals**

Main and Auxilliary Output: BNC connectors on front only for Bench Model 4200 and rear of chassis only for Rack Model 4200R.

External Synchronization: BNC connector on rear chassis, only.

**Dimensions and Weights**

Bench Model 4200, 8 1/2" wide, 5 1/4" high, 13 1/2" deep, 11 lbs/5kgs net, 18 lbs/8kgs shipping. Rack-mounting Model 4200R, 19" wide, 5 1/2" high, 13 1/2" deep, 15 lbs/6.8kgs net, 21 lbs/9.5kgs shipping.

# SECTION 2

# OPERATING INSTRUCTIONS

## 2.1 GENERAL

On receipt of the Test Oscillator, carefully examine it for any damage that may have occurred in transit. If damage is found, file a claim with the transporting agency immediately and notify your Krohn-Hite Representative, or Krohn-Hite Corporation directly. Do not attempt to use the Oscillator if extensive damage has occurred and do not ship the unit back until the carrier has inspected it. The instrument may be opened for inspection without nullifying the Warranty.

Rack-Mounting models mount with four machine screws in the standard 19" rack space. No special brackets or attachments are needed.

## 2.2 OPERATION

Figure 2 identifies and describes the function of all the front panel controls, connectors and indicators for the Model 4200.

To operate the Model 4200 proceed as follows:

a. Make appropriate power connection as described in Section 2.4.

b. Turn Power Switch to ON position.

c. Select the desired frequency with the pushbutton Frequency Multiplier and Frequency Dial. For precise frequency setting, connect a frequency counter to the Auxiliary Output and use the Frequency Vernier for fine adjustment.

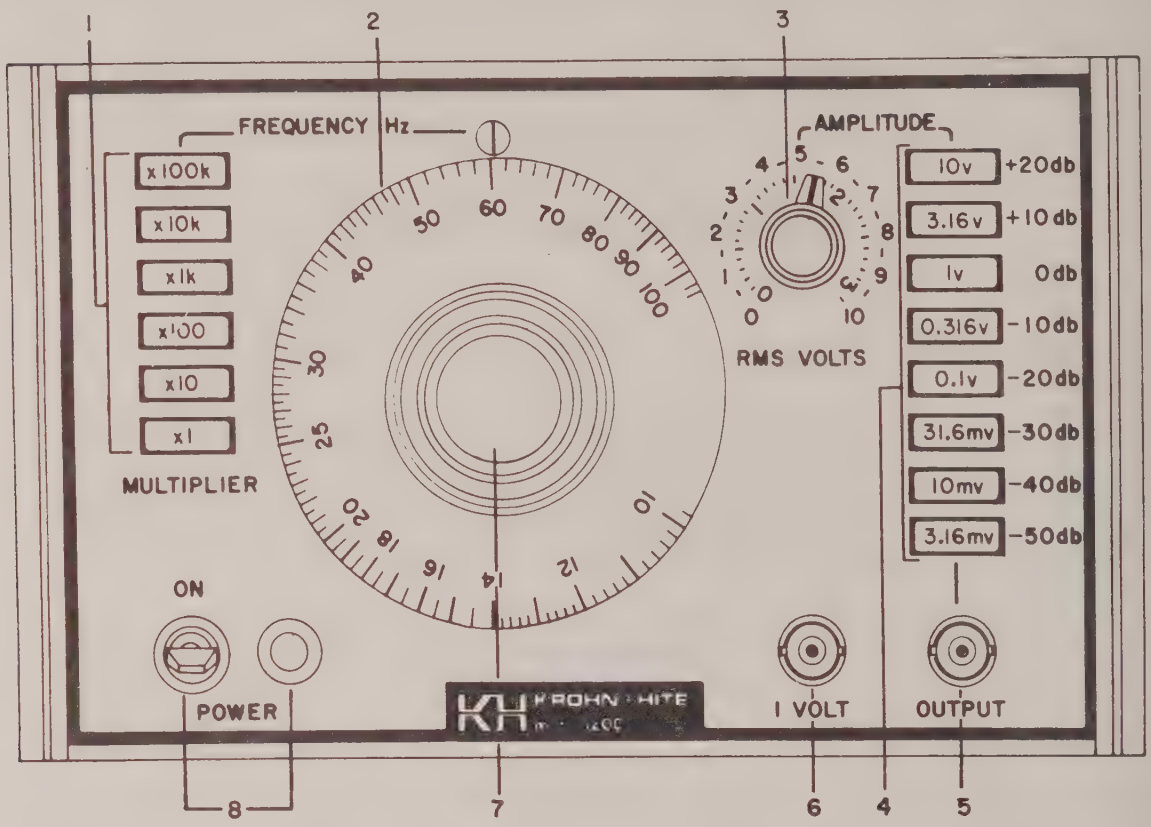
d. Set the pushbutton Output Attenuator switch to the minimum voltage range that would include the desired output voltage.

e. Connect load to output connector.

f. Adjust Amplitude control for desired output voltage.

## 2.3 EXTERNAL SYNCHRONIZATION

An EXTERNAL SYNC connector on the rear of the chassis is provided to synchronize the frequency of the Oscillator to an external signal. Connect the external signal to the EXTERNAL SYNC. input connector and set the Oscillator dial to the frequency desired.




(1) Frequency Multiplier: Selects one of six frequency ranges, from 10Hz to 10MHz.

(2) Frequency Dial: Varies output frequency within each frequency range. Dial reading multiplied by Frequency Multiplier is the output frequency.

(3) Variable Amplitude Control: Adjusts the amplitude of signal applied to the Output Attenuator.

(4) Output Attenuator: Attenuates the output of the Test Oscillator in 7 steps of 10db each.

(5) Main Output Connector: Provides the main output signal at an impedance level of 50 ohms (on rear only for Rack model).

(6) Auxiliary Output: Provides 1V RMS auxiliary output signal at an impedance level of 600 ohms (on rear only for Rack model).

(7) Frequency Vernier: Provides a fine adjustment of frequency.

(8) Power On and Pilot Light: Switch applies power to the Oscillator and lamp glows to indicate application of power.

Figure 2. Front Panel Controls and Connection

With an external sine or square wave synchronizing signal of 1.5 volts peak-to-peak, the Oscillator output will be locked in frequency to the external signal over a locking range of approximately ±.5%. The Oscillator distortion will not increase with an external sine wave synchronizing signal but will increase to .5% for a square wave external signal. When the Oscillator frequency is the same as the external signal frequency, the Oscillator output will be 180° out of phase with the external synchronizing signal. A ±.5% variation in the Oscillator frequency will vary their relative phase by approximately ±90 degrees.

With a 10 volt peak-to-peak sine wave external synchronizing signal, the maximum recommended, the locking range will increase to 2% and the distortion will remain the same. With a square wave external signal the same locking range of 2% will be obtained but the distortion will rise to approximately 1%.

### 2.4 LINE VOLTAGE AND FUSES

The Oscillator can be wired for operation from an AC power source or either 105-125 volts, 50-400Hz, or 210-250 volts, 50-400Hz. When connected for 105-125 volt operation, the terminals of the power transformer are jumpered so that 1 is connected with 3, and 2 is connected with 4. With this voltage, the oscillator uses a 0.3 ampere slow-blow fuse mounted on the rear of the chassis. When wired for 210-250 volt operation, the jumper between terminals 1 and 3, and the jumper between terminals 2 and 4 are removed and terminal 2 is connected to terminal 3. A 0.15 ampere slow-blow fuse should be used with this voltage.

Access to the interior of the oscillator is accomplished by removing the four screws centered at the rear of each cover; sliding off the side covers will unlock the top and bottom covers.

# SECTION 3

# CIRCUIT DESCRIPTION

## 3.1 INTRODUCTION

The Model 4200, shown in the Simplified Schematic Diagram, Figure 3 and Schematic Diagram, Figure 9 is a Wein Bridge R-C Oscillator whose frequency is determined by the network $R_1C_1$ and $R_2C_2$. Amplitude consistency is attained by a unique FET AVC system. An output amplifier is used to provide 1/2 watt power and a low output impedance. A pushbutton attenuator has been provided to give a constant 50 ohm output impedance.

## 3.2 FREQUENCY DETERMINING CIRCUIT

The tuning control consists of a dual variable capacitor $C_1C_2$ and a six station pushbutton switch, varying the resistive element $R_1R_2$ in decade ranges. The frequency vernier action is accomplished by a friction drive on the main shaft and controlled by a concentric knob mounted on the main control knob providing a 5 to 1 vernier action.

## 3.3 OSCILLATOR AMPLIFIER

The Oscillator Amplifier consists of a two stage, direct-coupled differential amplifier. One input is from the tuning divider $R_1C_1$, $R_2C_2$ and is buffered by an input FET Q201 to the plus input of the differential pair Q202, Q203. The minus input is driven directly from the AVC divider network R219, R221, R225 and Q207. The second stage Q205 is driven from the collectors of the first stage and in turn drives the output follower Q206.

The variable output control P301, is capacitor-coupled from the emitter of Q206 and provides the driving signal for the output amplifier.

## 3.4 AVC

To maintain a high degree of amplitude stability and minimize transients, a dual AVC circuit is employed. One AVC circuit is used for quick recovery when large transients occur and the other to maintain long term stability and minimum amplitude variations when frequency tuning.

For fast recovery when transients occur, the Oscillator Amplifier output is fed through divider R108 and R107 to diodes CR101 and CR102. These diodes are

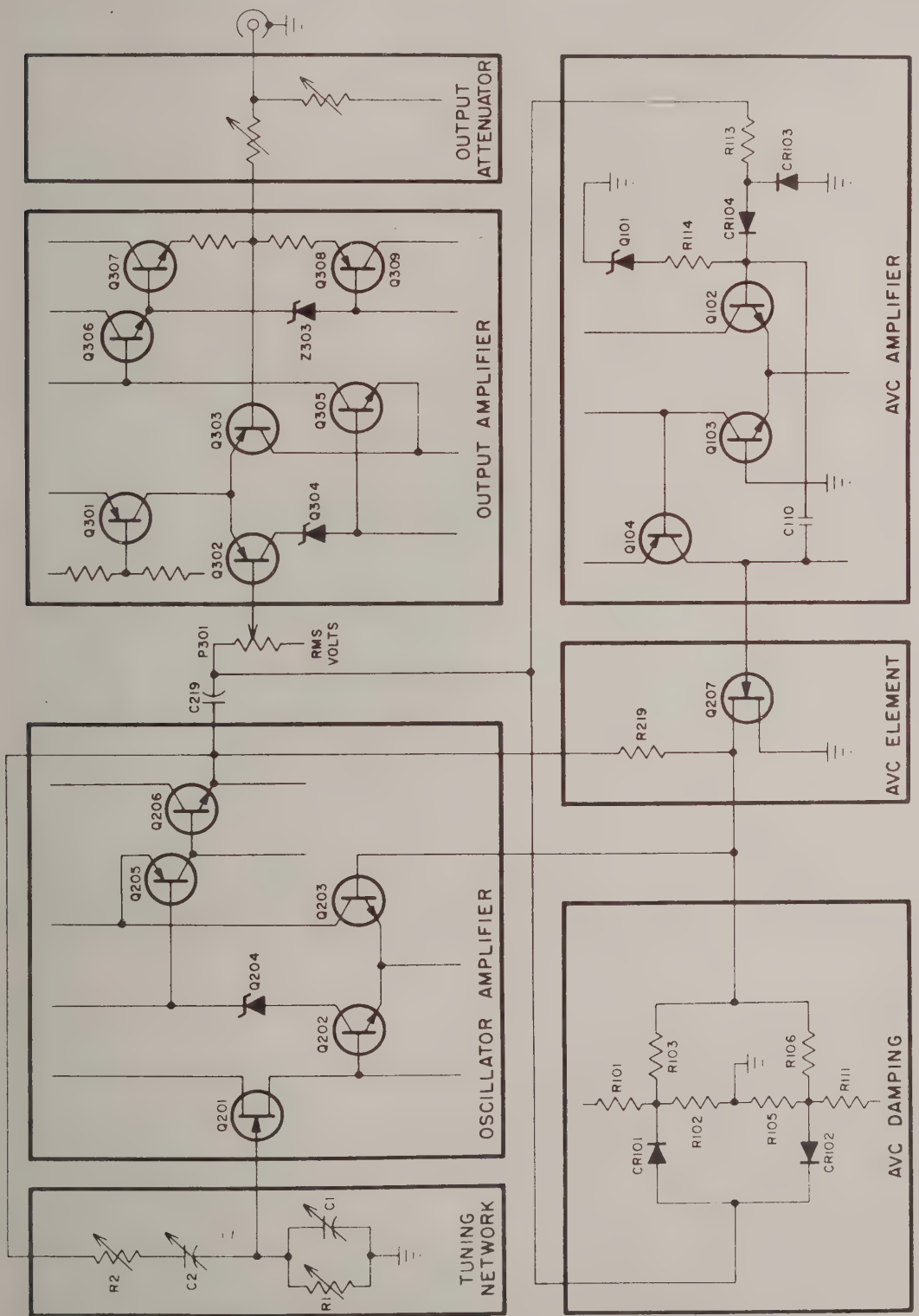



Figure 3. Simplified Schematic Diagram

biased only to conduct when larger than normal signals occur. In this event, diodes CR101 and CR102 conduct at the peaks of the sine wave. This signal is fed to the input of the Oscillator Amplifier, stabilizing and reducing the gain of the Oscillator Amplifier.

The main AVC action is accomplished by feeding the output of the Oscillator Amplifier to a d-c converter consisting of CR103 and CR104. The current in CR104 is summed with the reference current in R114, determined by the transistor Q101 base and emitter junction used as a zener. The summing point is fed to the input of a two stage integrator consisting of an input differential amplifier Q102, Q103 and output stage Q104, that maintains the summing point at zero. The output of the integrator drives a FET transistor Q207 operated in a variable resistance mode and connected in the feedback circuit of the Oscillator Amplifier. The amplitude of the Oscillator Amplifier is controlled by the integrator output and Q207 in order to maintain the proper current in CR104 for a zero input voltage of the integrator.

### 3.5 OUTPUT AMPLIFIER

The Output Amplifier is a two stage, direct-coupled, differential amplifier consisting of an input stage Q302 and Q303; a second stage of gain Q305 drives an emitter follower Q306 which in turn drives a complimentary emitter follower output stage Q307, Q308 and Q309. The feedback is taken from the emitters of the output stage, summed in resistors R321 and R322, R324, R325 and fed back to the input stage. Q301 maintains constant current in the input stage. The base to emitter junction of Q304 is used as a zener to provide proper biasing for the first stage. The output is added through resistors R323 and R326, R327. An additional series resistor consisting of R330 and R331 provides a constant 50 ohm impedance to the output attenuator.

### 3.6 OUTPUT ATTENUATOR

The Output Attenuator consists of a cascade of resistors that reduce to a simple divider on all positions except the maximum output position. The resistor values have been selected to give 10db increments with a constant 50 ohm output impedance.

### 3.7 POWER SUPPLY

The power supply provides two regulated voltages of plus 22 and minus 22 volts. The plus regulator is identical in operation to the minus regulator. It consists of a full wave rectifier CR401 and filter capacitors C401 and C402. Both supplies are of the typical series type. The plus 22 volts output is summed with the offset voltage from Z404 through resistors R416 and R418. This voltage is held constant by the action of the input amplifier Q405 driving the second stage amplifier Q402, which in turn drives the series regulator Q401. Z403 provides a reference voltage for the plus supply, and a d-c offset for the minus supply. The minus supply operates in the same manner with the summing resistors being R415 and R421, and input stage Q406, second stage Q403, and series transistor Q404. Both supplies may be grounded without damage. Grounding either supply turns off the input stage, which in turn, shuts off the second stage and the series transistor. With the short removed, normal operation is restored through the action of Z401 and CR401 in the plus supply and Z402 and CR402 in the minus supply.

# SECTION 4

# MAINTENANCE

## 4.1 INTRODUCTION

If the oscillator is not functioning properly and requires service the following procedure may facilitate locating the source of trouble. Access to the interior of the oscillator is accomplished by removing the four screws centered at the rear of each cover; sliding off the side covers will unlock the top and bottom covers. The general layout of major components of the oscillator is shown in Figure 4. The oscillator consists of an unregulated power supply chassis in the rear, a large printed circuit card PC420, two printed circuit cards, PC423 and PC424 for the frequency multiplier and a printed circuit card, PC421 associated with the Output Attenuator.

When a malfunction is detected, first check the line voltage and line fuse and then make an inspection for broken wires, burnt or loose components, poor solder points or similar conditions which could cause trouble. Before beginning troubleshooting it should be determined if the normal adjustments mentioned in the Calibration and Adjustment procedure, Section 5, will correct the trouble. Any troubleshooting of the oscillator will be greatly simplified if there is an understanding of the operation of the circuit; reference should be made to Circuit Description, Section 3. When a problem is encountered, it should first be determined if the malfunction is present under all conditions, or is only present under certain conditions such as a specific multiplier position, a particular section of the frequency dial or at some specific amplitude setting. If the problem seems to be of a general nature, the troubleshooting procedure outlined here should be followed. If the trouble is only present under specific conditions, however, the procedure must be adapted to fit the circumstance.

## 4.2 PRELIMINARY CHECK

The oscillator should be set as follows:

1. Frequency Multiplier switch at x100.
2. Frequency dial at 10.
3. Output RMS Volts in maximum cw position.

If a d-c voltage on the output cannot be adjusted to zero when the RMS Volts control is turned to zero the malfunction is most likely in the Output Amplifier consisting of transistors Q301 to Q309. Check the plus and minus 22 volt supplies. If these levels are off more than ±0.5V refer to Section 4.3. If these voltages are correct refer to Section 4.4.

If the instrument is not functioning properly and the d-c voltage at FO is incorrect the defective area, in most cases, is in the Oscillator Amplifier section, consisting of Q201 to Q206. Check the plus and minus 22 volt supplies. If these levels are off more than ±0.5V refer to Section 4.3. If these levels are correct refer to Section 4.6.

If the d-c output level cannot be adjusted to zero with the OUTPUT DC LEVEL control and can be adjusted when the output RMS VOLTS control is turned to zero the malfunction is most likely in the AVC damping circuit or the Oscillator Amplifier. Further measurements should be made with the RMS VOLTS control in the zero position so as not to damage the output transistors of the Output Amplifier.

### 4.3 POWER SUPPLY

An apparent failure of the plus and minus 22 volt supplies may be caused by excessive current being drawn by other parts of the circuit. An abnormal load on the plus 22V supply may cause the plus supply to drop to less than plus 2 volts. Due to the interaction of the plus and minus supplies the minus 22 volts would probably drop to minus 15 volts. In the same manner an excessive load on the minus supply would cause it to drop to less than minus 2 volts and the plus supply to drop to plus 15 volts.

An apparent malfunction in the power supply caused by excessive current can be determined by measuring the voltage drop across the decoupling resistors R121 and R215 of the Oscillator Amplifier or by measuring the voltage drop across the decoupling resistors R319 and R329 of the Output Amplifier. The voltage drop across these decoupling resistors is normally 0.2 volts and may exceed 0.5 volts when excessive current exists. If excessive current is the cause of incorrect supply voltages the most likely source of trouble is shorted output transistor in the Oscillator Amplifier or Output Amplifier. If the power supply is functioning properly, refer to Section 4.6 Oscillator Amplifier or Section 4.4 Output Amplifier.

If the power supply is defective the following procedure is recommended. Due to the interactions between the plus and minus supplies, the malfunctioning supply will in most cases be the supply with the greatest error.

Normal voltages for various points are given on the Schematic Diagram Figure 9. The normal ripple on the plus and minus 22 volts supplies is less than [ 5 millivolts rms] 15 millivolts peak to peak. If the supplies are not working properly, trace the error signal developed through the circuit to find the faulty component.

For example, if the plus supply were lower than normal the base of Q405 would become more negative than normal increasing the current in Q405. This action would make the base of Q402 more positive increasing the current in Q402, turning on the series transister Q401, restoring the plus 22 to its normal level. The point at which this corrective action is blocked will localize the defective component. In the same manner, if the minus 22 volt supply is not negative enough Q406 would have higher current than normal increasing the current in Q403 which in turn increases the current in the series transistor Q404 restoring the minus supply to its correct value.

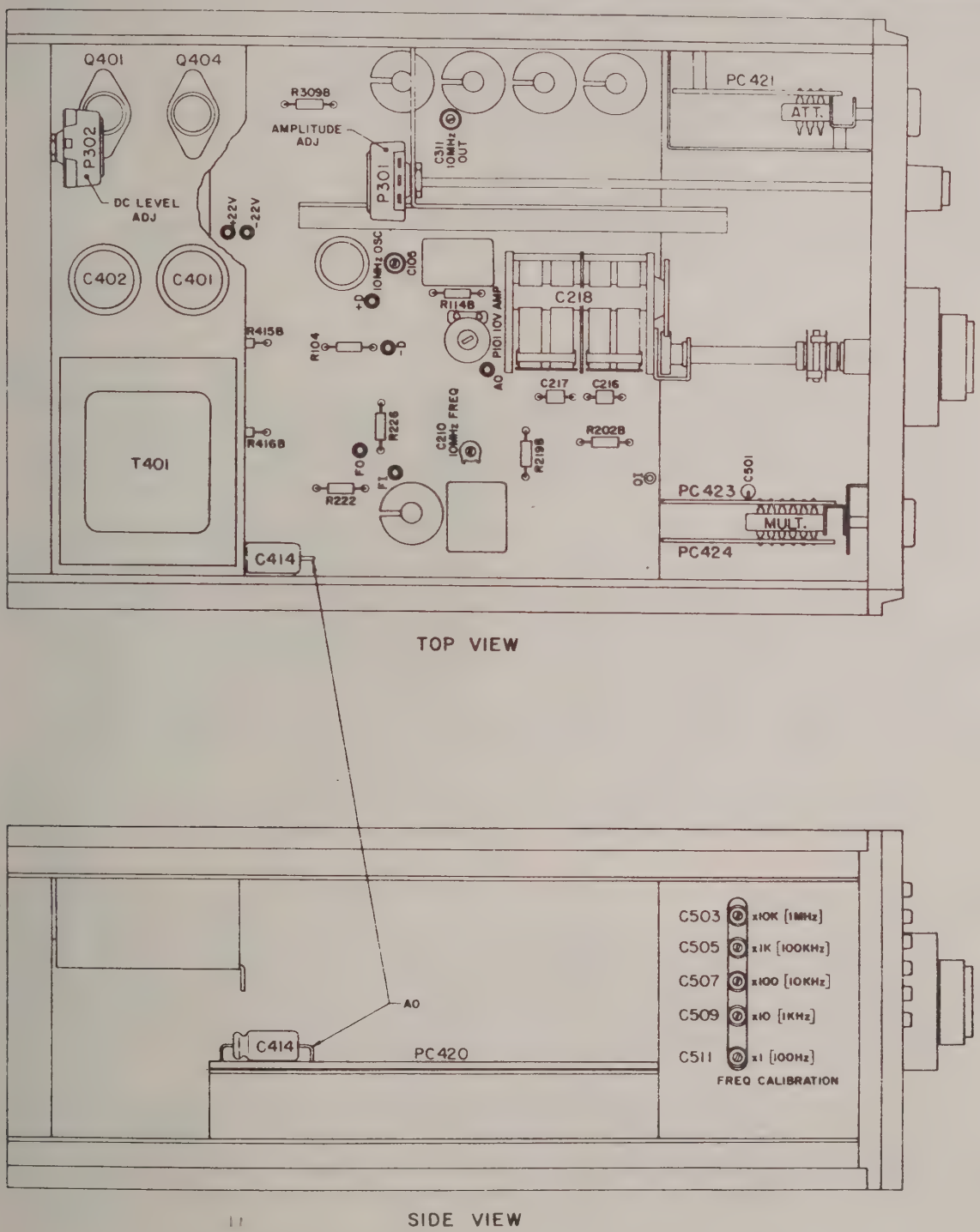



Figure 4. View Showing Major Components

This power supply circuit requires bleeder current for starting. These components consist of Z401, CR401 and R404 in the plus supply and Z402, CR402 and R407 in the minus supply. If any of these components are open the malfunctioning supply voltage will be very low. An open bleeder circuit may be determined by shunting momentarily the collector to base of the series transistors Q401 or Q408 with a 2K resistor. If normal voltage is restored the most likely trouble is either an open zener, Z401 or Z402, or an open diode CR401 or CR402.

If it is necessary to replace a reference zener Z403 or Z404, it will probably be necessary to adjust R416B or R415B for the correct plus or minus voltage respectively.

### 4.4 OUTPUT AMPLIFIER

Most defects in the output amplifier will produce a d-c voltage on the output (MO) that will not adjust to zero with the OUTPUT DC LEVEL control. With the RMS VOLTS control at zero, the error signal developed may be traced through the circuit as follows:

Assume the output d-c level is positive. This will decrease the current in Q303 and increase the current in Q302 making the collector of Q302 less negative than normal. The current in Q305 will increase making its collector more negative, decreasing the current in Q306. This will decrease the current in Q307 and increase the current in Q308 and Q309 restoring the output to its normal value. The point at which this corrective action is blocked will localize the faulty component.

If any one of Q307, Q308 or Q309 are found to be defective the other two should be checked for shorts, along with Q305 and Q306.

If it is found necessary to replace Q305, Q306, Q307, Q308 or Q309 it will be necessary to adjust C311 for optimum frequency response at 10MHz.

### 4.5 OUTPUT ATTENUATOR

If the trouble is a small error in attenuation the most likely defective component will be located at the switch position where the error is first noticed when switching down from the maximum output setting. If the malfunction is an open or a short a large attenuation error will result, localizing the problem to a specific switch position.

To minimize effects of stray capacity and maintain proper attenuation over the entire frequency range, all unused switch positions are connected to ground. If this grounding is not maintained due to a defective switch or a poor solder connection, the frequency response and attenuation accuracy will be in error only at high frequencies.

### 4.6 OSCILLATOR AMPLIFIER

If the instrument is not functioning properly and the d-c voltage at FO is incorrect, the defective area, in most cases is the Oscillator Amplifier. Troubleshooting should be done with the dial at 10, multiplier at x100 and the RMS VOLTS control at zero.

If the FO and FI d-c levels are incorrect but improve when switching the multiplier from the x100 position to the x100k position the most likely source of trouble is excessive gate leakage in Q201. If it is necessary to change Q201, the FI level should be adjusted to zero with R202B and frequency calibration at 10MHz should be adjusted with C210. (All frequency checks should be made with all covers in place). To localize the defective area, connect a 330 ohm resistor from the gate of Q201 (OI) to ground. Check the d-c level at FO and FI. If these levels are correct, the trouble area is associated with either the tuning network and multiplier switch or excessive gate leakage in Q201.

Remove the 330 ohm resistor from the gate of Q201 and connect it between the base of Q202 and ground. If the d-c level at FO is still incorrect, the trouble is in the Oscillator Amplifier loop and the error signal may be traced in the following manner.

Let us assume the output level, FO, is more negative than normal. This should make the base of Q203, FI, more negative, decreasing the current in Q203 and increasing the current in Q202. This will make the base of Q205 more negative increasing the current in Q205 and making the base of Q206 more positive increasing the current in Q206 making its emitter, FO, more positive correcting the output level. The point at which this corrective action is blocked will localize the trouble area. If it is necessary to change any transistors in the Oscillator Amplifier it may be necessary to adjust C210 for the correct 10 MHz frequency calibration. (Frequency checks should be made with all covers in place.)

### 4.7 AVC AMPLIFIER

If the signal at FO is not 3 volts rms the most probable source of trouble is in the AVC Amplifier. Check the d-c voltage at the emitter of Q101. If it is not 6.3±.5 volts the most likely source of trouble is Q101. If Q101 is replaced, it will probably be necessary to reset the maximum output voltage to 10.2 volts by readjusting P101. If P101 does not have sufficient range, adjust the value of R114B.

If the emitter of Q101 is correct, check the AO d-c level. When the rms signal at FO is high the AO d-c level should be saturated at approximately minus 6 volts d-c. When the rms signal at FO is low or zero the AO d-c level should be saturated at approximately plus 1.3 volts. If the error voltage at AO is not in the direction indicated for the condition stated at FO, trace the error voltage through the AVC Amplifier in the following manner.

If the rms voltage at FO is greater than 3 volts rms, the d-c voltage at the base of Q102 should be more positive than normal, increasing the current in Q102 and decreasing the current in Q103. This will reduce the emitter to base voltage of Q104 decreasing the current in Q104, making the d-c level at AO more negative.

If the FO is less than 3 volts rms, the error signal developed will be in the opposite direction and may be traced through the circuit in the same manner. The point at which this corrective action is blocked will localize the trouble area.

If the AVC Voltage (AO) is acting properly and the rms voltage at FO is incorrect the most likely source of trouble is the Field Effect Transistor (FET) Q207, or its associated circuitry. If Q207 is replaced it may be necessary to readjust distortion. Set the dial to 10 and multiplier at x100. Adjust R226 for minimum distortion at 1kHz. Switch the multiplier to x10. Adjust R222 for minimum distortion at 100Hz.

### 4.8 AVC DAMPING

If the output has amplitude modulation or excessive ringing after switching, the most likely source of trouble is the AVC damping circuit. Tune to a frequency below 100kHz where the amplitude is stable. Adjust P101, AMP ADJ, for a maximum output of 10.2VRMS open circuit on the main output. If this does not correct the trouble, observe the pulses at + D and -D. If the pulses are different than shown in Figure 5, adjust R104. If adjusting R104 will not correct the + D and -D pulses, it may be necessary to adjust R111. If these adjustments cannot be made, the trouble may be CR101, or CR102, or their associated components may be defective.

### 4.9 TUNING NETWORK

In addition to a frequency calibration error, a defective tuning component, R506 thru R521 or C216, C217 may cause the amplitude to be high or low or no oscillation at all. If a tuning component is replaced it may be necessary to adjust the AVC output voltage (AO) (see Section 5.7).

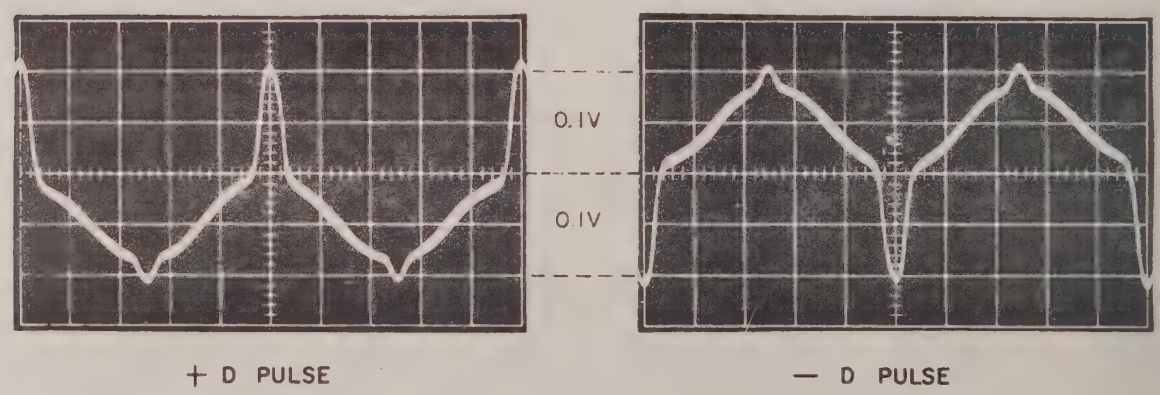



Figure 5. Pulses at + D and -D

# SECTION 5

# CALIBRATION AND ADJUSTMENT

## 5.1 INTRODUCTION

Before attempting any adjustments the procedure in Section 6 should be followed to determine if adjustments are necessary. The following procedure is provided for the purpose of facilitating the adjustment and calibration of the oscillator in the field, and adherence to this procedure should restore the oscillator to its original specifications. If any difficulties are encountered, please refer to Maintenance, Section 4. If any questions arise which are not covered by this procedure, please contact our factory service department. The location of all major components, modular sub-assemblies, test points, screw driver controls and adjustments are shown in Figure 4.

Access to the interior of the oscillator is accomplished easily by removing the four screws centered at the rear of each cover; sliding off the side covers will unlock the top and bottom covers.

## 5.2 TEST EQUIPMENT REQUIRED

The following test equipment is required to perform these adjustments:

a. High impedance d-c voltmeter capable of measuring 1mv to 50V.

b. A-c Voltmeter capable of measuring 15vrms ±1%.

c. Oscilloscope with response greater than 10MHz.

d. Distortion Analyzer capable of measuring less than .1% distortion from 10Hz to 100KHz.

e. Frequency counter capable of 10Hz to 10MHz measurements.

f. Flatness measuring equipment such as Fluke 10V Thermal Converter Model A55, High Impedance Voltmeter - Null Detector Model 845A and a d-c reference supply or similar equipment capable of response measurements to 10MHZ with accuracies of 0.25%.

## 5.3 POWER SUPPLY

a. Set oscillator dial to 10, multiplier to x100.

b. Set the RMS VOLTS control to zero and attenuator to 10V (+20db) position.

c. Connect a d-c voltmeter between ground and +22 volt point.

d. Adjust R416B for +22 ±0.2V.

e. Connect the d-c voltmeter to the -22 volt point.

f. Adjust R415B for -22 ±0.2V.

### 5.4 OSCILLATOR AMPLIFIER D-C LEVEL

a. Stop oscillation by connecting a 330 ohm resistor from the gate of Q201 to ground. (Test point QI to ground).

b. Connect the d-c voltmeter to test point FI and adjust R202B for 0±50mv at FI.

### 5.5 OUTPUT AMPLIFIER D-C LEVEL

a. Connect the d-c voltmeter to the main output of the oscillator.

b. Adjust P302 for 0±3mv.

c. Turn RMS VOLTS control to maximum CW position and adjust R309B for a d-c level change of less than 10mv. Remove 330 ohm resistor between OI and ground.

### 5.6 OUTPUT AMPLITUDE

Set oscillator dial to 10, multipler X100, RMS VOLTS control maximum CW and attenuator at 10V (+20db).

a. Connect a-c voltmeter to main output.

b. Adjust P101 for 10.2vrms at output. If P101 does not have enough range, set P101 to center of range and adjust R114B for 10.2vrms at main output.

### 5.7 AVC DAMPING

a. Measure pulse with scope at test points +D and -D.

b. Adjust R104 for pulses of 0.1V. (See Figure 5).

### 5.8 AVC VOLTAGE (AO)

a. Replace the top, bottom and right side cover for shielding, leaving access through the left side.

b. Connect the d-c voltmeter to test point AO (C414 see Figure 4) and a frequency counter to the oscillator main output.

c. Set frequency dial to 10 end, multiplier to X100.

d. Adjust R219B for an AO voltage of -2.5 ±0.25 vdc.

e. Turn dial for 1kHz reading on counter. If necessary loosen dial set screws and readjust dial for correct calibration at 10 and lightly tighten set screws.

f. Turn dial to 100 and adjust C216 and C217 for 10kHz calibration and a change at AO of less than 0.5 volts from voltage at 10 end of dial.

g. Partially replace left side cover for shielding and use C509 for a final frequency calibration adjustment. Tighten dial set screws.

h. With dial set at 100, measure AO voltage on other multiplier positions. If off more than ±2V from setting at X100 multiplier position, check frequency calibration.

### 5.9 FREQUENCY CALIBRATION

a. Set dial at 100.

b. On X1 multiplier, adjust C511 at 100Hz.

c. On X10 multiplier, adjust C509 at 1kHz.

d. On X1K multiplier, adjust C505 at 100kHz.

e. On X100K multiplier, adjust C210 and C501 for 10MHz frequency calibration and minimum AO voltage change when tuning from 10 to 100 on dial.

f. On X10K multiplier, adjust C503 for 1MHz.

### 5.10 DISTORTION

a. Remove voltmeter and counter.

b. Connect Distortion Analyzer to output.

c. With dial set at 100 multiplier X10 adjust R226 for minimum distortion at 1KHz.

d. With dial set at 10 multiplier X10 adjust R222 for minimum distortion at 100Hz.

### 5.11 FREQUENCY RESPONSE

Connect response measuring equipment across P301, RMS VOLTS control. (See Figure 6). Set oscillator dial to 100 multiplier to 1K position. Set RMS VOLTS and attenuator for maximum output. Adjust reference voltage for null. Switch frequency multiplier to 100K(10MHz). Adjust C105 for null. Connect response measuring equipment to oscillator main output through a 50-ohm Feedthrough Terminator resistor. Set oscillator dial to 100 multiplier to 1K position. Adjust reference voltage for null. Switch frequency multiplier to 100K(10MHz). Adjust C311 for null.

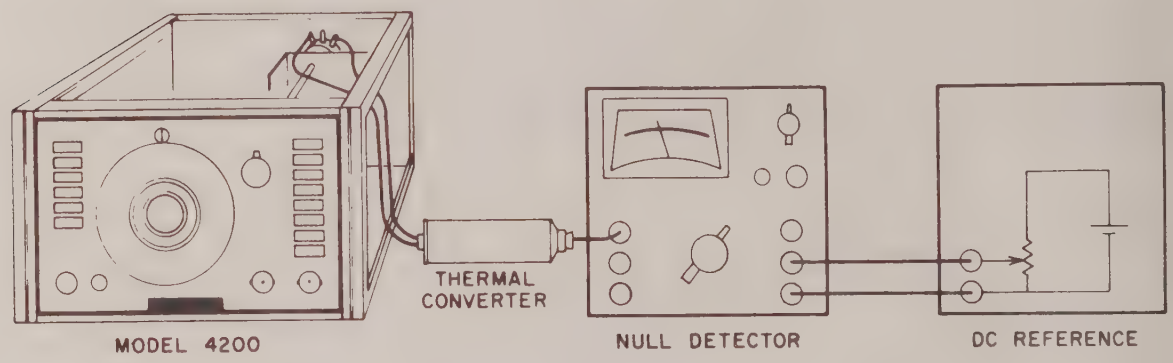



Figure 6. Flatness Response Measurement

# SECTION 6

# INCOMING ACCEPTANCE AND PERFORMANCE CHECKS

## 6.1 INTRODUCTION

The following procedure should be used to verify the Model 4200 is operating within specifications. These checks may be used for incoming inspection and periodic specification checks. Tests must be made with all covers in place. If the instrument is not operating within specifications refer to Section 5 before attempting any detailed maintenance.

## 6.2 TEST EQUIPMENT REQUIRED

Same as listed in Section 5.2.

## 6.3 DIAL ACCURACY

Connect Frequency Counter to the Oscillator output. Set Oscillator to the frequency indicated and check counter indication.

| OSCILLATOR Frequency (Hz) | COUNTER Indication | COUNTER Function |
|---|---|---|
| 10 | 100±3ms | Period |
| 100 | 10±0.2ms | |
| 500 | 2±0.04ms | Average |
| 1K | 1000±20 | |
| 5K | 5000±100 | |
| 10K | 10K±0.2K | |
| 50K | 50K±1K | |
| 100K | 100K±2K | Frequency |
| 500K | 500K±10K | |
| 1M | 1M±20K | Hz |
| 10M | 10M±300K | |

Table 6.1

### 6.4 MAIN OUTPUT

a. Power, Voltage, Current, Impedance; Set Oscillator to 1kHz, set output attenuator to 10V position, adjust RMS VOLTS control for 10 Vrms at OUTPUT, connect 50±.2% ohm load across OUPTUT, output should drop to 5V±0.05 volts. Observe OUTPUT at frequencies between 10Hz and 10MHz. Output should not clip or distort.

b. DC Component; Adjust OUTPUT DC LEVEL control on rear of chassis for zero d-c at OUTPUT terminal with RMS VOLTS control to the CCW end.

c. Distortion; Connect Distortion Analyzer to Oscillator Output. Measure distortion at each frequency listed in Table 6.1. For frequencies between 100 Hz and 100kHz distortion should be less than 0.1%. At 10Hz and 500 kHz distortion readings should be less than 0.5%. Equipment for measuring total harmonic distortion above 500kHz is not known to be commercially available.

d. Frequency Response; Connect response measuring equipment to OUTPUT. Set Oscillator to 1kHz and adjust d-c ref voltage for null. Check each frequency listed in Table 6.1. Flatness should be within ±0.25% (0.025db) for frequencies to 500kHz and ±5% (0.5db) at 10MHz, into a matched 50 ohm load.

### 6.5 AUXILIARY OUTPUT

Set Oscillator to 1kHz. Connect RMS voltmeter to 1 VOLT output connector. Measure 1 Volt. Connect 600 ohm load to 1 VOLT output. Output should drop to 0.5 volts.

### 6.6 OUTPUT ATTENUATOR

Set Oscillator to 1kHz. Connect 50 ohm load and rms meter to main OUTPUT. Adjust RMS VOLTS control for 20db reading on rms meter. Check each attenuation position for 10db±0.2db drop.

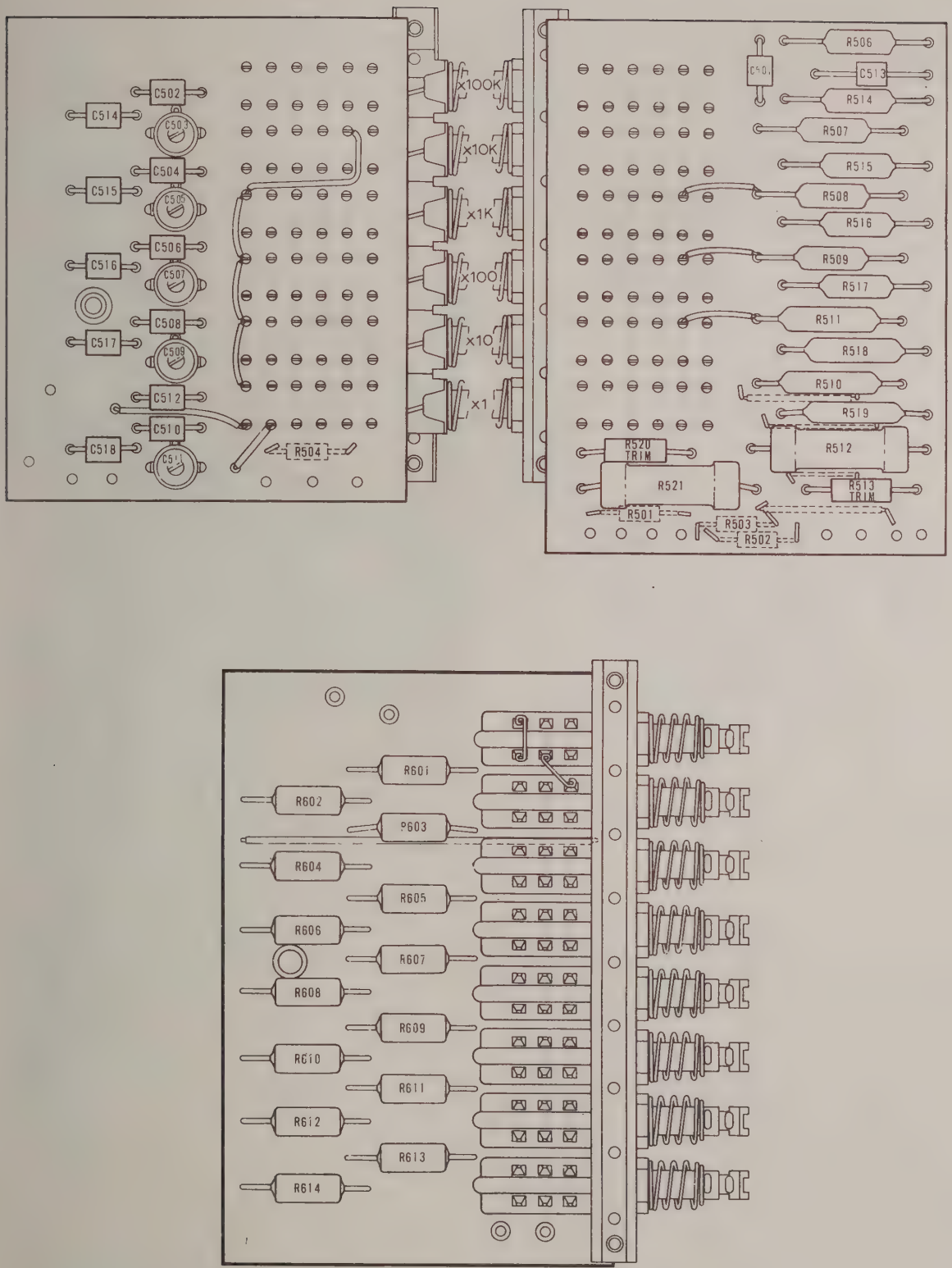



Figure 7. PC423, PC424, and PC421 Component Board Layout.

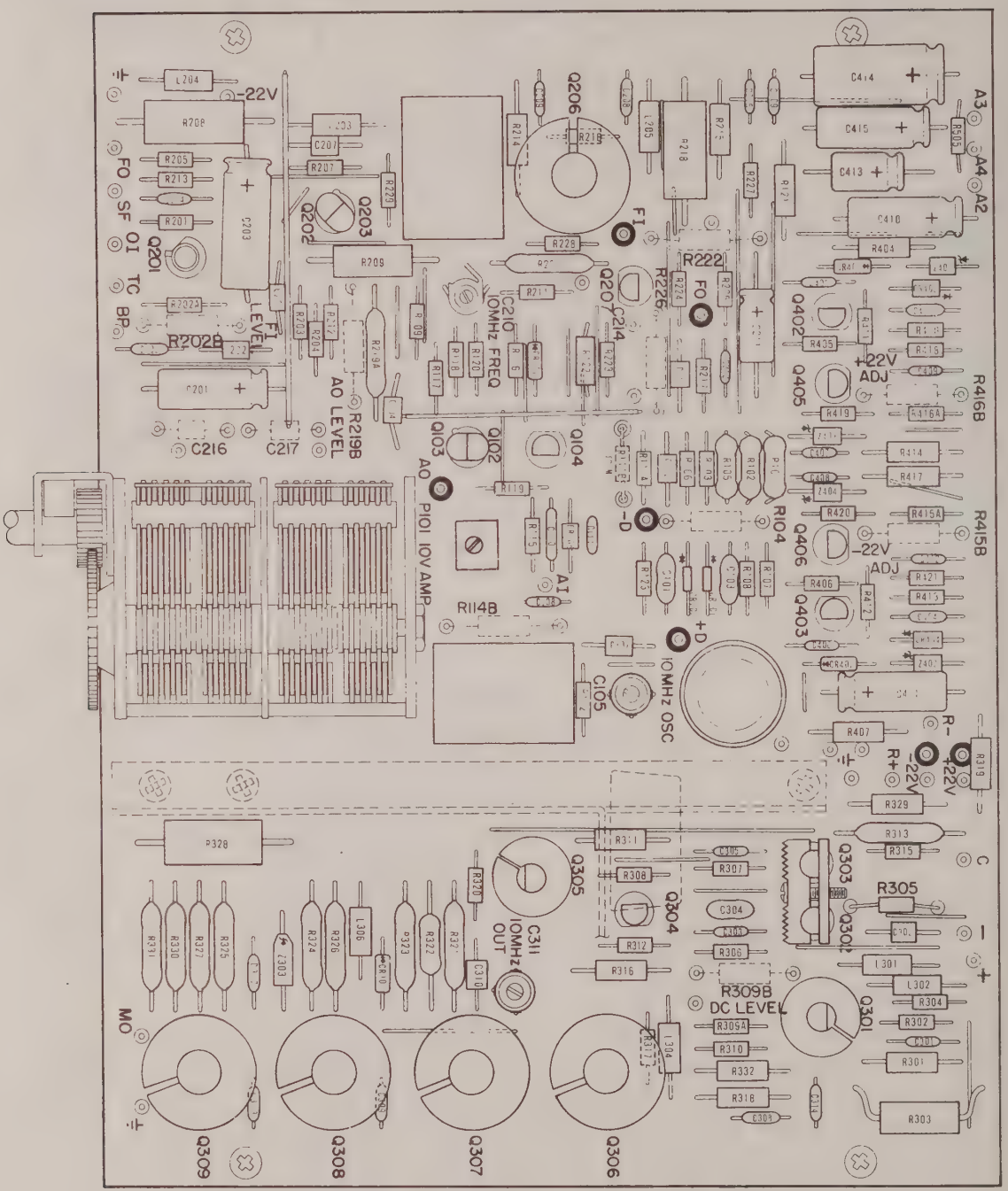
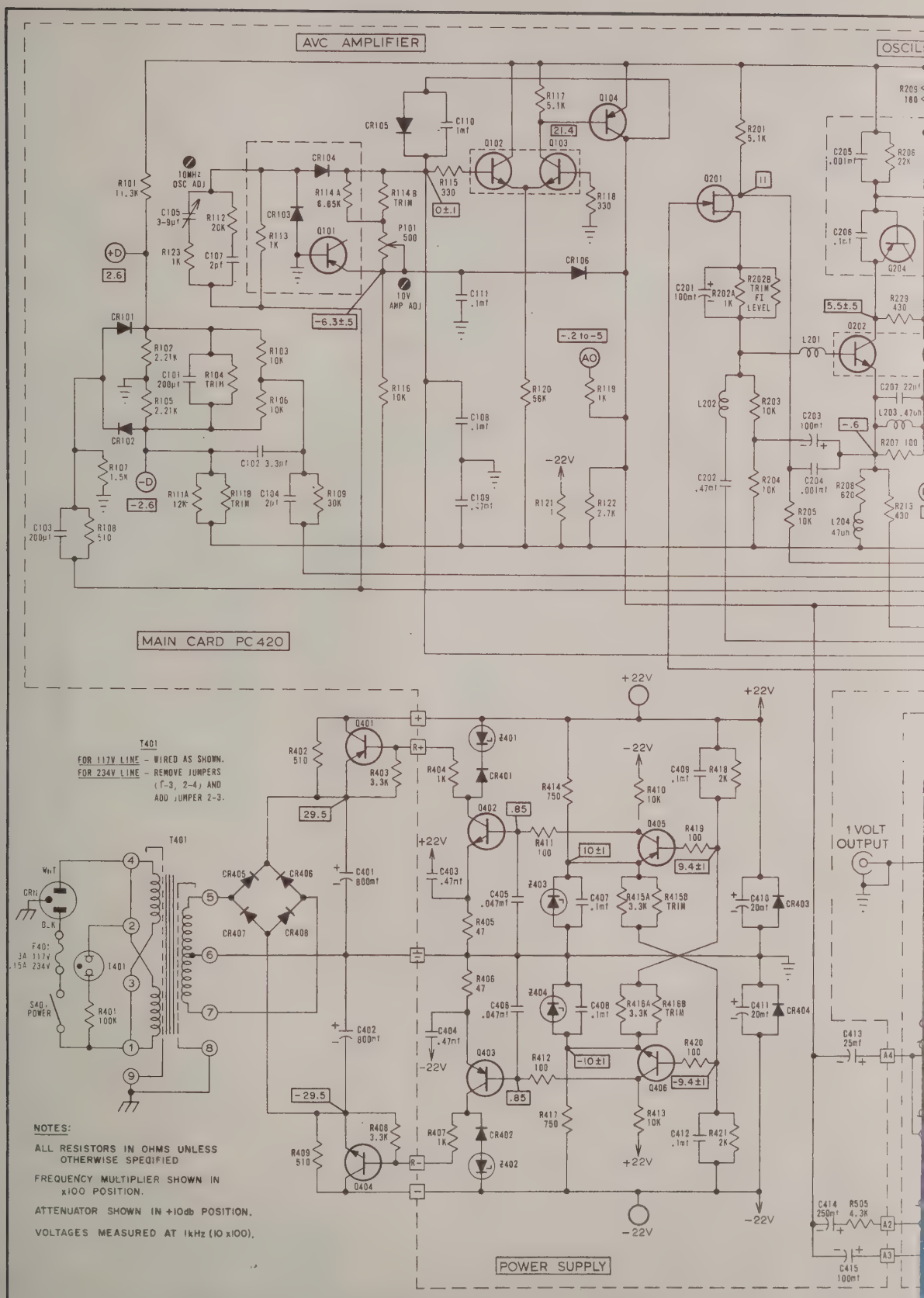
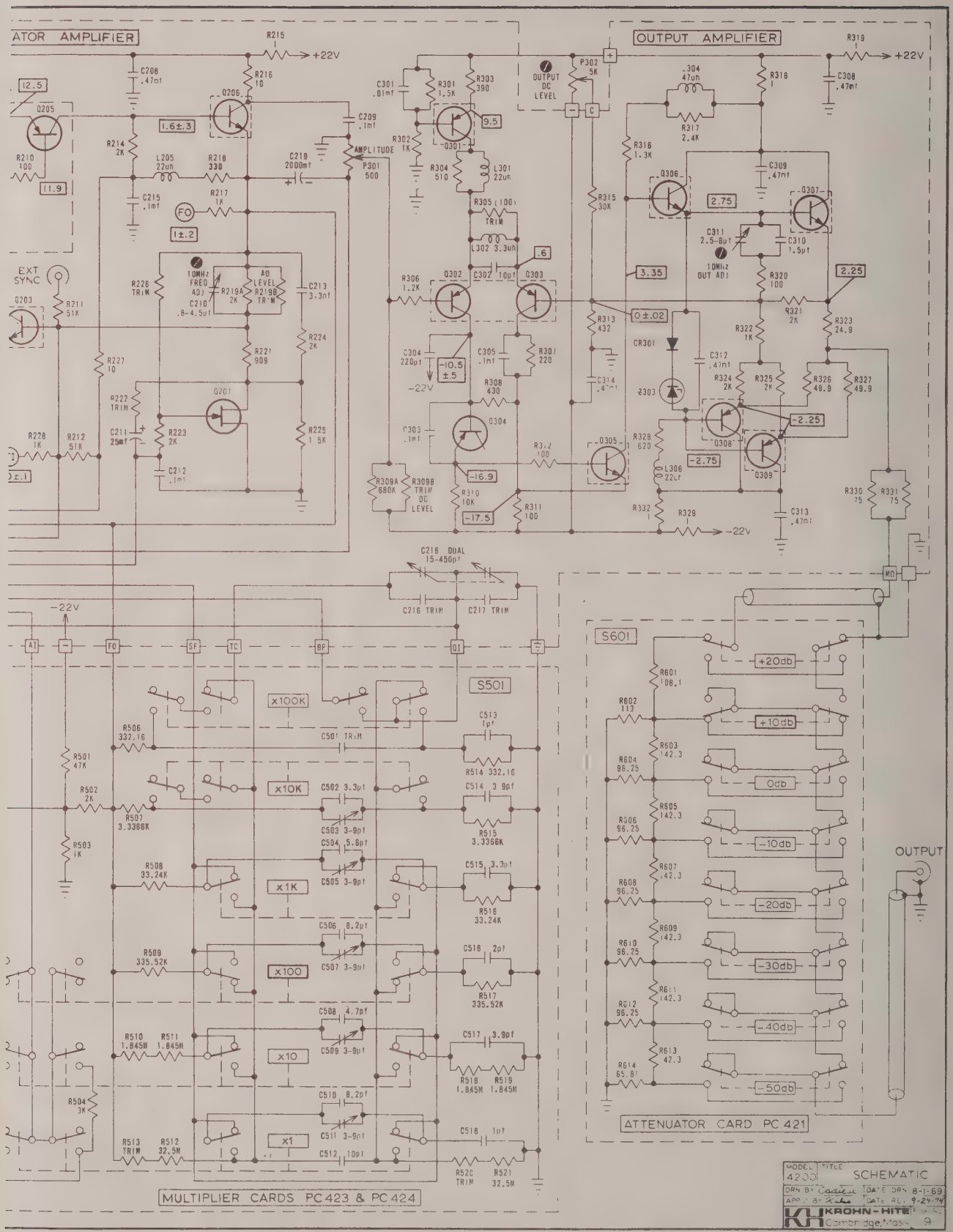



Figure 8. PC420 Component Board Layout.


AVC AMPLIFIER
OSCIL
MAIN CARD PC420
POWER SUPPLY
T401
FOR 117V LINE – WIRED AS SHOWN.
FOR 234V LINE – REMOVE JUMPERS (1-3, 2-4) AND ADD JUMPER 2-3.
NOTES:
ALL RESISTORS IN OHMS UNLESS OTHERWISE SPECIFIED
FREQUENCY MULTIPLIER SHOWN IN x100 POSITION.
ATTENUATOR SHOWN IN +10db POSITION.
VOLTAGES MEASURED AT 1kHz (10 x100).
1 VOLT OUTPUT
+22V
-22V


ATOR AMPLIFIER
OUTPUT AMPLIFIER
+22V
-22V
AMPLITUDE
OUTPUT DC LEVEL
EXT SYNC
10MHz FREQ ADJ
AO LEVEL R219A R219B TRIM
10MHz OUT ADJ
C218 DUAL 15-450pf
C216 TRIM
C217 TRIM
S501
S601
x100K
x10K
x1K
x100
x10
x1
+20db
+10db
0db
-10db
-20db
-30db
-40db
-50db
OUTPUT
MULTIPLIER CARDS PC423 & PC424
ATTENUATOR CARD PC 421
MODEL 4200
TITLE SCHEMATIC
DRN BY Cadieux
DATE DRN 8-1-69
APP'D BY Kuhn
DATE REL 9-24-69
KROHN-HITE
Cambridge, Mass.
9

## RESISTORS

| Symbol | Description | | | Mfr. | Part No. |
|---|---|---|---|---|---|
| R101 | 11.3K | 1% | 1/8W | KH | M3-T1-11.3K |
| R102 | 2.21K | 1% | 1/8W | KH | M3-T1-2.21K |
| R103 | 10K | 5% | 1/4W | AB | CB1035 |
| R104 | TRIM | | | | |
| R105 | 2.21K | 1% | 1/8W | KH | M3-T1-2.21K |
| R106 | 10K | 5% | 1/4W | AB | CB1035 |
| R107 | 1.5K | 5% | 1/4W | AB | CB1525 |
| R108 | 510 | 5% | 1/4W | AB | CB5115 |
| R109 | 30K | 5% | 1/4W | AB | CB3035 |
| R111A | 12K | 10% | 1/4W | AB | CB1231 |
| R111B | TRIM | | | | |
| R112 | 20K | 5% | 1/4W | AB | CB2035 |
| R113 | 1K | 1% | 1/4W | KH | M4-T1-1K |
| R114A | 6.65K | 1% | 1/8W | KH | M3-T1-6.65K |
| R114B | TRIM | | | | |
| R115 | 330 | 10% | 1/4W | AB | CB3311 |
| R116 | 10K | 10% | 1/4W | AB | CB1031 |
| R117 | 5.1K | 5% | 1/4W | AB | CB5125 |
| R118 | 330 | 10% | 1/4W | AB | CB3311 |
| R119 | 1K | 10% | 1/4W | AB | CB1021 |
| R120 | 56K | 10% | 1/4W | AB | CB5630 |
| R121 | 1 | 10% | 1/2W | AB | EB10G1 |
| R122 | 2.7K | 10% | 1/2W | AB | EB2721 |
| R123 | 1K | 5% | 1/4W | AB | CB1025 |
| R201 | 5.1K | 5% | 1/4W | AB | CB5125 |
| R202A | 1K | 5% | 1/4W | AB | CB1025 |
| R202B | TRIM | FI | LEVEL | | |
| R203 | 10K | 5% | 1/4W | AB | CB1035 |
| R204 | 10K | 5% | 1/4W | AB | CB1035 |
| R205 | 10K | 5% | 1/4W | AB | CB1035 |
| R206 | 22K | 10% | 1/4W | AB | CB2231 |
| R207 | 100 | 5% | 1/4W | AB | CB1015 |
| R208 | 620 | 5% | 1/2W | AB | HB6215 |
| R209 | 160 | 5% | 1/2W | AB | EB1615 |
| R210 | 100 | 10% | 1/4W | AB | CB1011 |
| R211 | 51K | 5% | 1/4W | AB | CB5135 |
| R212 | 51K | 5% | 1/4W | AB | CB5135 |
| R213 | 430 | 5% | 1/4W | AB | CB4315 |
| R214 | 2K | 5% | 1/2W | AB | EB2025 |
| R215 | 1 | 10% | 1/2W | AB | EB10G1 |
| R216 | 10 | 10% | 1/4W | AB | CB1001 |
| R217 | 1K | 10% | 1/4W | AB | CB1021 |
| R218 | 330 | 10% | 2W | AB | HB3311 |
| R219A | 2K | 1% | 1/2W | KH | M5-T1-2K |
| R219B | TRIM | | | | |
| R221 | 909 | 1% | 1/8W | KH | M3-T1-909 |
| R222 | TRIM | | | | |
| R223 | 2K | 5% | 1/4W | AB | CB2025 |
| R224 | 2K | 5% | 1/4W | AB | CB2025 |
| R225 | 1.5K | 5% | 1/4W | AB | CB1525 |
| R226 | TRIM | | | | |
| R227 | 10 | 10% | 1/4W | AB | CB1001 |
| R228 | 1K | 10% | 1/4W | AB | CB1021 |
| R229 | 430 | 5% | 1/4W | AB | CB4315 |
| R301 | 1.5K | 5% | 1/2W | AB | EB1525 |
| R302 | 1K | 5% | 1/4W | AB | CB1025 |
| R303 | 390 | 5% | 1W | AB | GB3915 |
| R304 | 510 | 5% | 1/4W | AB | CB5115 |
| R305 | TRIM | | | | |
| R306 | 1.2K | 10% | 1/4W | AB | CB1221 |
| R307 | 220 | 10% | 1/4W | AB | CB2211 |
| R308 | 430 | 5% | 1/4W | AB | CB4315 |
| R309A | 680K | 5% | 1/4W | AB | CB6815 |
| R309B | TRIM | | | | |
| R310 | 10K | 10% | 1/4W | AB | CB1031 |
| R311 | 100 | 5% | 1/2W | AB | EB1015 |
| R312 | 100 | 10% | 1/4W | AB | CB1011 |
| R313 | 432 | 1% | 1/8W | KH | M3-T1-432 |
| R315 | 30K | 5% | 1/4W | AB | CB3035 |
| R316 | 1.3K | 5% | 1/2W | AB | EB1325 |
| R317 | 2.4K | 5% | 1/4W | AB | CB2425 |
| R318 | 1 | 10% | 1/2W | AB | EB10G1 |
| R319 | 1 | 10% | 1/2W | AB | EB10G1 |

| Symbol | Description | | | Mfr. | Part No. |
|---|---|---|---|---|---|
| R320 | 100 | 5% | 1/4W | AB | CB1015 |
| R321 | 2K | 1% | 1/2W | KH | M5-T1-2K |
| R322 | 1K | 1% | 1/4W | KH | M4-T1-1K |
| R323 | 24.9 | 1/4% | 1/2W | KH | M5-T1-24.9 |
| R324 | 2K | 1% | 1/2W | KH | M5-T1-2K |
| R325 | 2K | 1% | 1/2W | KH | M5-T1-2K |
| R326 | 49.9 | 1/4% | 1/2W | KH | M5-T1-49.9 |
| R327 | 49.9 | 1/4% | 1/2W | KH | M5-T1-49.9 |
| R328 | 620 | 5% | 2W | AB | HB2615 |
| R329 | 1 | 10% | 1/2W | AB | EB10G1 |
| R330 | 75 | 1/4% | 1/2W | KH | M5-T1-75 |
| R331 | 75 | 1/4% | 1/2W | KH | M5-T1-75 |
| R332 | 1 | 10% | 1/2W | AB | EB10G1 |
| R401 | 100K | 10% | 1/4W | AB | CB1011 |
| R402 | 510 | 5% | 1/2W | AB | EB5115 |
| R403 | 3.3K | 10% | 1/4W | AB | CB3321 |
| R404 | 1K | 10% | 1/2W | AB | EB1021 |
| R405 | 47 | 5% | 1/4W | AB | CB4705 |
| R406 | 47 | 5% | 1/4W | AB | CB4705 |
| R407 | 1K | 10% | 1/2W | AB | EB1021 |
| R408 | 3.3K | 10% | 1/4W | AB | CB3321 |
| R409 | 510 | 5% | 1/2W | AB | EB5115 |
| R410 | 10K | 10% | 1/4W | AB | CB1031 |
| R411 | 100 | 10% | 1/4W | AB | CB1011 |
| R412 | 100 | 10% | 1/4W | AB | CB1011 |
| R413 | 10K | 10% | 1/4W | AB | CB1031 |
| R414 | 750 | 5% | 1/2W | AB | EB7515 |
| R415A | 3.3K | 5% | 1/4W | AB | CB3325 |
| R415B | TRIM | | | | |
| R416A | 3.3K | 5% | 1/4W | AB | CB3325 |
| R416B | TRIM | | | | |
| R417 | 750 | 5% | 1/2W | AB | EB7515 |
| R418 | 2K | 5% | 1/4W | AB | CB2025 |
| R419 | 100 | 10% | 1/4W | AB | CB1011 |
| R420 | 100 | 10% | 1/4W | AB | CB1011 |
| R421 | 2K | 5% | 1/4W | AB | CB2025 |
| R501 | 47K | 5% | 1/4W | AB | CB4735 |
| R502 | 2K | 5% | 1/4W | AB | CB2025 |
| R503 | 1K | 5% | 1/4W | AB | CB1025 |
| R504 | 3K | 5% | 1/4W | AB | CB3025 |
| R505 | 4.3K | 5% | 1/4W | AB | CB4325 |
| R506 | 332.16 | 1/4% | 1/8W | KH | M3-T1-332.16 |
| R507 | 3.3366K | 1/4% | 1/8W | KH | M3-T1-3.3366K |
| R508 | 33.24K | 1/4% | 1/8W | KH | M3-T1-33.24K |
| R509 | 335.52K | 1/4% | 1/8W | KH | M3-T1-335.52K |
| R510 | 1.845M | 1/4% | 1/2W | KH | M5-T1-1.845M |
| R511 | 1.845M | 1/4% | 1/2W | KH | M5-T1-1.845M |
| R512 | 32.5M | 2% | 1W | KH | DCF-32.5M |
| R513 | TRIM | | | | |
| R514 | 332.16 | 1/4% | 1/8W | KH | M3-T1-332.16 |
| R515 | 3.3366K | 1/4% | 1/8W | KH | M3-T1-3.3366K |
| R516 | 33.24K | 1/4% | 1/8W | KH | M3-T1-33.24K |
| R517 | 335.52K | 1/4% | 1/8W | KH | M3-T1-335.52K |
| R518 | 1.845M | 1/4% | 1/2W | KH | M5-T1-1.845M |
| R519 | 1.845M | 1/4% | 1/2W | KH | M5-T1-1.845M |
| R520 | TRIM | | | | |
| R521 | 32.5M | 2% | 1W | KH | DCF-32.5M |
| R601 | 108.1 | 1% | 3/4W | KH | M6-T1-108.1 |
| R602 | 113 | 1% | 1/2W | KH | M5-T1-113 |
| R603 | 142.3 | 1% | 1/4W | KH | M4-T1-142.3 |
| R604 | 96.25 | 1% | 1/8W | KH | M3-T1-96.25 |
| R605 | 142.3 | 1% | 1/4W | KH | M4-T1-142.3 |
| R606 | 96.25 | 1% | 1/8W | KH | M3-T1-96.25 |
| R607 | 142.3 | 1% | 1/4W | KH | M4-T1-142.3 |
| R608 | 96.25 | 1% | 1/8W | KH | M3-T1-96.25 |
| R609 | 142.3 | 1% | 1/4W | KH | M4-T1-142.3 |
| R610 | 96.25 | 1% | 1/8W | KH | M3-T1-96.25 |
| R611 | 142.3 | 1% | 1/4W | KH | M4-T1-142.3 |
| R612 | 96.25 | 1% | 1/8W | KH | M3-T1-96.25 |
| R613 | 142.3 | 1% | 1/4W | KH | M4-T1-142.3 |
| R614 | 65.81 | 1% | 1/8W | KH | M3-T1-65.81 |

## CAPACITORS

| Symbol | Description | | | Mfr. | Part No. |
|---|---|---|---|---|---|
| C101 | 200pf | 10% | 500V | ELM | DM15C201K |
| C102 | 3.3pf | 10% | 500V | ASP | 9209-33910 |
| C103 | 200pf | 10% | 500V | ELM | DM15C201K |
| C104 | 2pf | 10% | 500V | ASP | 9208-20910 |
| C105 | 3-9pf | TRIMMER | | STT | 7S-TRIKO-02 |
| C107 | 2pf | 10% | 500V | ASP | 928-20910 |
| C108 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C109 | .47mf | 20% | 100V | ERT | 8131-100-651-474M |
| C110 | 1mf | +80%-20% | 25V | SP | 5C023105D8250B3 |
| C111 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |

| Symbol | | | | Mfr. | Part No. |
|---|---|---|---|---|---|
| C201 | 100mf | | 6V | SP | 30D107G006CC4 |
| C202 | .47mf | 20% | 100V | ERT | 8131-100-651-474M |
| C203 | 100mf | | 25V | SP | 30D107G025DD4 |
| C204 | 1000pf | 20% | 500V | SP | C023B501E102M |
| C205 | 1000pf | 20% | 500V | SP | C023B501E102M |
| C206 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C207 | 22pf | 10% | 500V | ELM | DM15C220K |
| C208 | .47mf | 20% | 100V | ERT | 8131-100-651-474M |
| C209 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C210 | .8-4.5pf | TRIMMER | | ERT | 561-013 |

## CAPACITORS (Cont.)

| Symbol | Description | | | Mfr. | Part No. |
|---|---|---|---|---|---|
| C211 | 25mf | | 16V | SP | 30D256G016BB4 |
| C212 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C213 | 3.3pf | 10% | 500V | ASP | 9209-33910 |
| C214 | TRIM | | | | |
| C215 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C216 | TRIM | | | | |
| C217 | TRIM | | | | |
| C218 | 15-450pf | DUAL | | KH | 5084-2-450-LH-G25 |
| C219 | 2000 mf | | 6V | SP | 62D-D48227 |
| C301 | .01mf | 20% | 100V | ERT | 8121-100-651-103M |
| C302 | 10pf | 10% | 500V | ASP | 9213-10110 |
| C303 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C304 | 220pf | 10% | 500V | ASP | 9214-22120 |
| C305 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C308 | .47mf | 20% | 100V | ERT | 8131-100-651-474M |
| C309 | .47mf | 20% | 100V | ERT | 8131-100-651-474M |
| C310 | 1.5pf | 10% | 500V | ASP | 9207-15910 |
| C311 | 2.5-6pf | TRIMMER | | STT | 7S-TR1K0-02 |
| C312 | .47mf | 20% | 100V | ERT | 8131-100-651-474M |
| C313 | .47mf | 20% | 100V | ERT | 8131-100-651-474M |
| C314 | .47mf | 20% | 100V | ERT | 8131-100-651-474M |
| C401 | 800mf | | 50V | SP | D48171 |
| C402 | 800mf | | 50V | SP | D48171 |
| C403 | .47mf | 20% | 100V | ERT | 8131-100-651-474M |
| C404 | .47mf | 20% | 100V | ERT | 8131-100-651-474M |
| C405 | .047mf | 20% | 100V | ERT | 8121-100-651-473M |
| C406 | .047mf | 20% | 100V | ERT | 8121-100-651-473M |

| Symbol | Description | | | Mfr. | Part No. |
|---|---|---|---|---|---|
| C407 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C408 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C409 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C410 | 20mf | | 50V | SP | 30D206G050CC4 |
| C411 | 20mf | | 50V | SP | 30D206G050CC4 |
| C412 | .1mf | 20% | 100V | ERT | 8131-100-651-104M |
| C413 | 25mf | | 16 | SP | 30D256G016BB4 |
| C414 | 250mf | | 6V | SP | 30D257G006DD4 |
| C415 | 100mf | | 6V | SP | 30D107G006CC4 |
| C501 | TRIM | | | ASP | Type 53 |
| C502 | 3.3pf | 10% | 500V | ASP | 9209-33910 |
| C503 | 3.9pf | TRIMMER | | STT | 7S-TR1K0-02 |
| C504 | 5.6pf | 10% | 500V | ASP | 9210-56910 |
| C505 | 3-9pf | TRIMMER | | STT | 7S-TR1K0-02 |
| C506 | 8.2pf | 10% | 500V | ASP | 9212-82910 |
| C507 | 3-9pf | TRIMMER | | STT | 7S-TR1K0-02 |
| C508 | 4.7pf | 10% | 500V | ASP | 9212-82910 |
| C509 | 3-9pf | TRIMMER | | STT | 7S-TR1K0-02 |
| C510 | 8.2pf | 10% | 500V | ASP | 9212-82910 |
| C511 | 3-9pf | TRIMMER | | STT | 7S-TR1K0-02 |
| C512 | 12pf | 10% | 500V | ASP | 9213-10110 |
| C513 | 1pf | 10% | 500V | ASP | 9206-10910 |
| C514 | 3.9pf | 10% | 500V | ASP | 9208-20910 |
| C515 | 3.3pf | 10% | 500V | ASP | 9209-33910 |
| C516 | 2pf | 10% | 500V | ASP | 9209-33910 |
| C517 | 3.9pf | 10% | 500V | ASP | 9209-33910 |
| C518 | 1pf | 10% | 500V | ASP | 9206-10910 |

## TRANSISTORS, DIODES & MISC.

| Symbol | Description | Mfr. | Part No. |
|---|---|---|---|
| Q101 | MPS3640 | MOT | MPS3640 |
| Q102 | T1S97 | TI | T1S97 |
| Q103 | T1S97 | TI | T1S97 |
| Q104 | MPS6518 | MOT | MPS6518 |
| Q201 | 2N4340 | SIL | 2N4340 |
| Q202 | MPS6515 | MOT | MPS6515 |
| Q203 | MPS6515 | MOT | MPS6515 |
| Q204 | MPS3640 | MOT | MPS3640 |
| Q205 | MPS6518 | MOT | MPS6518 |
| Q206 | 2N5189 | RCA | 2N5189 |
| Q207 | 2N5555 | MOT | 2N5555 |
| Q301 | MPS6518 | MOT | MPS6518 |
| Q302 | MPS6518 | MOT | MPS6518 |
| Q303 | MPS6518 | MOT | MPS6518 |
| Q304 | MPS3640 | MOT | MPS3640 |
| Q305 | MPS6566 | MOT | MPS6566 |
| Q306 | 2N5189 | RCA | 2N5189 |
| Q307 | 2N5189 | RCA | 2N5189 |
| Q308 | 2N2905A | MOT | 2N2905A |
| Q309 | 2N2905A | MOT | 2N2905A |
| Q401 | MJE2370 | MOT | MJE2370 |
| Q402 | MPS6566 | MOT | MPS6566 |
| Q403 | MPS6518 | MOT | MPS6518 |
| Q404 | MJE2520 | MOT | MJE2520 |
| Q405 | MPS6518 | MOT | MPS6518 |
| Q406 | MPS6566 | MOT | MPS6566 |
| CR101 | 1N4149 | TR | 1N4149 |
| CR102 | 1N4149 | TR | 1N4149 |
| CR103 | 1N4149 | TR | 1N4149 |
| CR104 | 1N4149 | TR | 1N4149 |
| CR105 | 1N4149 | TR | 1N4149 |
| CR106 | 1N456 | TR | 1N456 |

| Symbol | Description | Mfr. | Part No. |
|---|---|---|---|
| CR301 | 1N456 | TR | 1N456 |
| CR401 | 1N456 | TR | 1N456 |
| CR402 | 1N456 | TR | 1N456 |
| CR403 | 1N4002 | MSC | 1N4002 |
| CR404 | 1N4002 | MSC | 1N4002 |
| CR405 | 1N4002 | MSC | 1N4002 |
| CR406 | 1N4002 | MSC | 1N4002 |
| CR407 | 1N4002 | MSC | 1N4002 |
| CR408 | 1N4002 | MSC | 1N4002 |
| Z303 | 1N749A | CI | 1N749A |
| Z401 | 1N965B | CI | 1N965B |
| Z402 | 1N965B | CI | 1N965B |
| Z403 | 1N961B | CI | 1N961B |
| Z404 | 1N961B | CI | 1N961B |
| L201 | FERRITE BEAD | STK | 57-0181 |
| L202 | FERRITE BEAD | STK | 57-0181 |
| L203 | .47uh | DLV | 1537-06 |
| L204 | 47uh | DLV | 1537-60 |
| L205 | 22uh | DLV | 1537-44 |
| L301 | 22uh | DLV | 1537-44 |
| L302 | 3.3uh | DLV | 1537-24 |
| L304 | 47uh | DLV | 1537-60 |
| L306 | 22uh | DLV | 1537-44 |
| T401 | TRANSFORMER P100-94 | KH | B2660 |
| P101 | 500 | BKM | 72PM |
| P301 | 500 10% 2W | AB | J94972 |
| P302 | 5K 20% 2W | AB | JAIL040S502MC |
| F401 | Fuse .3A/117v Slo-Blo<br>.15A/235v Slo-Blo | BUS<br>BUS | MDL 3/10<br>MDL 15/100 |
| S401 | SWITCH, TOGGLE | CK | 7101 |
| S501 | SWITCH,MULTIPLIER | KH | 6XF-10-4U-GR-M |
| S601 | SWITCH,ATTENUATOR | KH | 8XF-10-2U-GR |

## MANUFACTURERS CODE

| | | | | | |
|---|---|---|---|---|---|
| AB | (01121) | Allen Bradley Co. | Milwaukee, Wisc. |
| AMZ | | American-Zettler, Inc. | Costa Mesa, Calif. |
| ASP | (82142) | Airco Speer | Dubois, Pa. |
| BKM | (30646) | Beckman Instr. Co. | Milwaukee, Wisc. |
| BUS | (71400) | Bussman Mfg. Div. | St. Louis, Mo. |
| CI | (06751) | Components, Inc. | Biddeford, Maine |
| CK | (09353) | C & K Components | Watertown, Mass. |
| DLV | (99800) | Delevan Electronics | East Aurora, N.Y. |
| ELM | (72136) | Electromotive Mfg. | Willimantic, Conn. |
| ERT | (72982) | Erie Technological | Erie, Pa. |
| KH | (88865) | Krohn-Hite Corp. | Cambridge, Mass. |
| MOT | (04713) | Motorola Semiconductor | Farmingdale, Mass. |
| MSC | (14552) | Micro-Semiconductor | Culver City, Calif. |
| RCA | (49671) | Radio Corp. of America | Harrison, N.J. |
| SIL | (17856) | Siliconix | Sunnyvale, Calif. |
| SP | (56289) | Sprague Electric Co. | North Adams, Mass. |
| STK | (78488) | Stackpole | St. Marys, Pa. |
| STT | | Stettner-Trush | Cazanovia, N.Y. |
| TI | (01295) | Texas Instruments, Inc. | Dallas, Texas |
| TR | (03877) | Transitron Electric Co. | Wakefield, Mass. |

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